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(71) Applicant: Oki Electric Industry Co., Ltd.

SPECIFICATION

1. Title of the Device

Pixel Tester for Liquid Crystal Display Panel

2. Claims

(1) A pixel tester for a liquid crystal display panel wherein pixels are arranged in a matrix of m rows by n columns (wherein m and n are natural numbers), the pixel tester comprising:

a light source that emits light toward the back side of the liquid crystal display panel;

a line sensor having photodetectors arrayed in the row direction of the arranged pixels, the line sensor being disposed on a surface of the liquid crystal display panel;

column-direction moving means for changing the position of the line sensor on the liquid crystal display panel in the column direction, which is orthogonal to the row direction, in steps corresponding to the array pitch of the

pixels arranged in the column direction; and

determination means for detecting a pixel defect according to the output of the line sensor.

(2) A pixel tester for a liquid crystal display panel according to claim 1, further comprising row-direction moving means for changing the position of the line sensor on the liquid crystal display panel in the row direction by a distance equal to the array pitch of the pixels arranged in the row direction.

3. Detailed Description of the Device

[Technical Field of the Device]

The present device relates to a pixel tester for a liquid crystal display panel having pixels arranged in a matrix.

[Description of the Related Art]

Fig. 2 is a schematic diagram of an active matrix liquid crystal display panel. As shown in the drawing, the liquid crystal display panel includes pixel electrodes 1 arranged in a matrix of n rows by m columns, thin film transistors (TFT) 2 connected to the pixel electrodes 1, m data lines 3-1 to 3-m connected to the TFTs 2, n scanning lines 4-1 to 4-n connected to the TFTs 2, an X driver 5 that supplies the data lines 3-1 to 3-m with data signals, and a Y driver 6 that supplies the scanning lines 4-1 to 4-n with scanning signals. The liquid crystal display panel further

includes a liquid crystal layer (not shown in the drawing) on the pixel electrodes 1 and a common electrode (not shown in the drawing) facing the pixel electrodes 1 on the liquid crystal layer. Data signals supplied from the data lines when the scanning signals are in the ON mode cause the pixel electrodes 1 to be charged via the TFTs 2, activating the pixels.

In the liquid crystal display panel having such a structure, the data lines, the scanning lines, the TFTs, and other components are formed of thin films. For this reason, the lines of the liquid crystal display panel are easily broken. Such line breakage may lead to pixel defects that preclude activation of the pixels. Conventionally, the pixel defects of the liquid crystal display panel have been visually inspected before shipment.

[Problems to be Solved by the Device]

Unfortunately, the liquid crystal display panel to be tested is provided with as many as about 900,000 pixels for 480 scanning lines by 1920 data lines. Therefore, pixel defects are sometimes overlooked and many hours are required for the conventional visual inspection for pixel defects.

An object of the present device is, therefore, to provide a pixel tester for a liquid crystal display panel that allows correct and quick pixel inspection so that the problems of the conventional visual inspection are solved.

[Means for Solving the Problems]

A pixel tester for a liquid crystal display panel wherein pixels are arranged in a matrix of m rows by n columns (wherein m and n are natural numbers) in accordance with the present device includes a light source that emits light toward the back side of the liquid crystal display panel; a line sensor having photodetectors arrayed in the row direction of the arranged pixels, the line sensor being disposed on a surface of the liquid crystal display panel; column-direction moving means for changing the position of the line sensor on the liquid crystal display panel in the column direction, which is orthogonal to the row direction, in steps corresponding to the array pitch of the pixels arranged in the column direction; and determination means for detecting a pixel defect according to the output of the line sensor.

In addition to the above structure, the pixel tester for a liquid crystal display panel in accordance with the present device further comprises row-direction moving means for changing the position of the line sensor on the liquid crystal display panel in the row direction by a distance equal to the array pitch of the pixels arranged in the row direction.

[Operation]

According to the present device, the back side of a

liquid crystal display panel is irradiated with light from a light source, and a line sensor having photodetectors arranged in the row direction is disposed on the surface of the liquid crystal display panel. For example, if the output of one photodetector disposed in the line sensor is not more than a threshold, the pixel disposed at a position corresponding to the photodetector is determined to have a defect. The same test is repeated for the pixels arranged in the subsequent rows by moving the line sensor in the column direction by column-direction moving means.

Furthermore, a pixel tester for a liquid crystal display panel according to the present device includes row-direction moving means for changing the position of the line sensor on the liquid crystal display panel in the row direction, which is the direction of the array of photodetectors, by a distance equal to the array pitch of the pixels arranged in the row direction. Even if the array pitch of the photodetectors disposed in the line sensor is different from that of the pixels arranged in the row direction, all pixels can be tested by moving the photodetectors in the line sensor over the pixels.

[Embodiment]

The present device will now be described with reference to an embodiment illustrated in the drawings.

Fig. 1 is a schematic perspective view of the

embodiment of a pixel tester for liquid crystal display panels according to the present device.

As shown in the drawing, the pixel tester of this embodiment includes a stage 1 having a transparent platform 1a that holds a liquid crystal display panel P; a stopper 2 against which one edge of the liquid crystal display panel P abuts so that the panel P is positioned in the Y direction (row direction); and a stopper 3 against which another edge of the liquid crystal display panel P abuts so that the panel P is positioned in the X direction (column direction). The liquid crystal display panel P is connected to an X driver 4 that supplies data signals to the data lines of the panel and a Y driver 5 that supplies scanning signals to the scanning lines of the panel.

The pixel tester of this embodiment further includes a pair of guide shafts 7 and 8 fixed between support blocks 6a on a support board 6, the guide shafts extending in the X direction; a contact line sensor 9 that moves along the guide shafts 7 and 8; a belt 12 stretched across pulleys 10 and 11 for moving the line sensor 9 in the X direction; and a motor 13 that rotates the pulley 11 for moving the line sensor 9 in the X direction.

Furthermore, a lamp 14 is provided under the stage 1 for emitting light toward the back side of the liquid crystal display panel P. Also provided under the stage 1,

although not shown in the drawing, is a mechanism which moves the lamp 14 in the X direction so that the lamp 14 and the line sensor 9 always face each other from opposite sides of the liquid crystal display panel P. Fig. 3 is a schematic front view of the stage 1. Although not shown in the drawing, the embodiment has a mechanism that rotates the stage 1 in the $\theta$ direction for aligning the pixel array of the liquid crystal display panel P with the photodetector array of the line sensor 9.

Referring to Fig. 1, reference numeral 15 indicates an A/D converter which converts an analog output from the line sensor 9 to a digital signal; reference numeral 16 indicates a line memory for storing the output from the A/D converter 15; and reference numeral 17 indicates a controller which operates the pixel tester and also determines the condition of the pixels based on the output data sent from the line memory 16.

In this embodiment having the above structure, the lamp 14 emits light toward the back side of the liquid crystal display panel P, and, when the output of a photodetector in the line sensor 9 arranged in the Y direction is not more than a threshold, the tester determines that the pixel facing the photodetector is defective. The motor 13 drives the line sensor 9 in the X direction, whereby the pixels in the subsequent rows are tested in the same manner. If the

array pitch of the photodetectors in the line sensor 9 and the array pitch of the pixels in the row direction are consistent with each other, all pixels can be tested by the same procedure described above.

However, the array pitch of the photodetectors in the line sensor 9 and the array pitch of the pixels in the row direction are not always consistent with each other. Fig. 4 is a schematic illustration showing an array pitch $W_G$ of pixels $G_1$ to $G_m$ which is different from an array pitch $W_S$ of photodetectors $S_1$ to $S_i$. Fig. 5 is an illustration of the output of the photodetectors $S_1$ to $S_i$ according to Fig. 4.

In this case, as shown at the bottom of Fig. 5, the photodetectors $S_1$ and $S_4$ are positioned substantially in the center of the pixels $G_1$ and $G_3$, respectively, while the photodetector $S_2$ is positioned between the pixels $G_1$ and $G_2$ and the photodetector $S_3$ is positioned at an edge of the pixel $G_2$. Thus, as shown at the top of Fig. 5, the outputs of the photodetector $S_1$ facing the pixel $G_1$ and the photodetector $S_4$ facing the pixel $G_3$ exceed the threshold H, while the outputs of the photodetectors $S_2$ and $S_3$ are determined to be not more than the threshold H even though the pixel $G_2$ is normal. In other words, the status of the pixel $G_2$ is determined incorrectly.

The present embodiment has a mechanism (not shown in the drawing) that moves the stage 1 in the Y direction to

change the position of the line sensor 9 on the liquid crystal display panel P by a distance equal to the array pitch $W_G$ of pixels in the Y direction. Even if some photodetectors are not positioned substantially in the centers of the respective pixels, this mechanism moves the stage 1 in the Y direction by the array pitch $W_G$, permitting the photodetectors to substantially face the centers of the pixels. Thus, moving the stage 1, before conducting the same test, to change the position of the liquid crystal panel P relative to the photodetectors in the line sensor 9 by one pixel pitch in the Y direction provides a successful result for the pixels tested incorrectly (for example, the pixel $G_2$).

The moving pitch and the number of movements in the X direction and the moving pitch in the Y direction, which can be calculated by the controller 17, may be determined according to the number of pixels and the array pitch of the liquid crystal display panel. For example, for the liquid crystal display panel P having pixels in 480 rows by 1,920 columns and a pixel pitch of 100 μm in the Y direction and 300 μm in the X direction, and for the contact line sensor 9 having size A4 and 16 detectors/dot (a pixel pitch of 62.5 μm and 3,456 dots), the line sensor 9 moves 479 times, each by 300 μm in the X direction, and the moving pitch in the Y direction is 100 μm.

[Advantages]

As described above, the present device can determine the presence of pixel defects according to the photodetector outputs of the line sensor when emitting light toward the back side of the liquid crystal display panel. In addition, the position of the line sensor on the liquid crystal display panel changes in the row direction by a distance equal to the array pitch of pixels in the row direction, enabling every pixel to be tested even if the array pitch of the photodetectors in the line sensor is different from that of the pixels in the row direction. Thus, the present device can test pixels correctly and quickly.

4. Brief Description of the Drawings

Fig. 1 is a schematic perspective view showing an embodiment of a pixel tester for a liquid crystal display panel according to the present device.

Fig. 2 is a schematic diagram of an active matrix liquid crystal display panel.

Fig. 3 is a front view of a stage and the vicinity thereof.

Fig. 4 is an illustration of the case that the array pitch of photodetectors in a line sensor is different from that of pixels.

Fig. 5 is an illustration of the photodetector outputs in Fig. 4.

1: STAGE

2: Y-DIRECTION STOPPER

3: X-DIRECTION STOPPER

4: X DRIVER

5: Y DRIVER

6: SUPPORT BOARD

6a: SUPPORT BLOCKS

7,8: GUIDE SHAFTS

9: LINE SENSOR

10,11: PULLEYS

12: BELT

13: MOTOR

14: LAMP

15: A/D CONVERTER

16: LINE MEMORY

17: CONTROLLER

P: LIQUID CRYSTAL DISPLAY PANEL

$G_1$-$G_m$: PIXELS

$S_1$-$S_i$: PHOTODETECTORS

Applicant for Utility Model Registration: Oki Electric Industry Co., Ltd.

Agent: Patent Attorney, Minoru MAEDA

Fig. 1

101: SCHEMATIC PERSPECTIVE VIEW SHOWING PIXEL TESTER ACCORDING TO EMBODIMENT

102: X (COLUMN DIRECTION)

103: Y (ROW DIRECTION)

4: X DRIVER

5: Y DRIVER

9: LINE SENSOR

12: BELT

13: MOTOR

14: LAMP

Fig. 2

201: CIRCUIT DIAGRAM OF LIQUID CRYSTAL DISPLAY PANEL TO BE TESTED

5: X DRIVER

6: Y DRIVER

Fig. 3

301: FRONT VIEW OF STAGE 1 AND VICINITY THEREOF

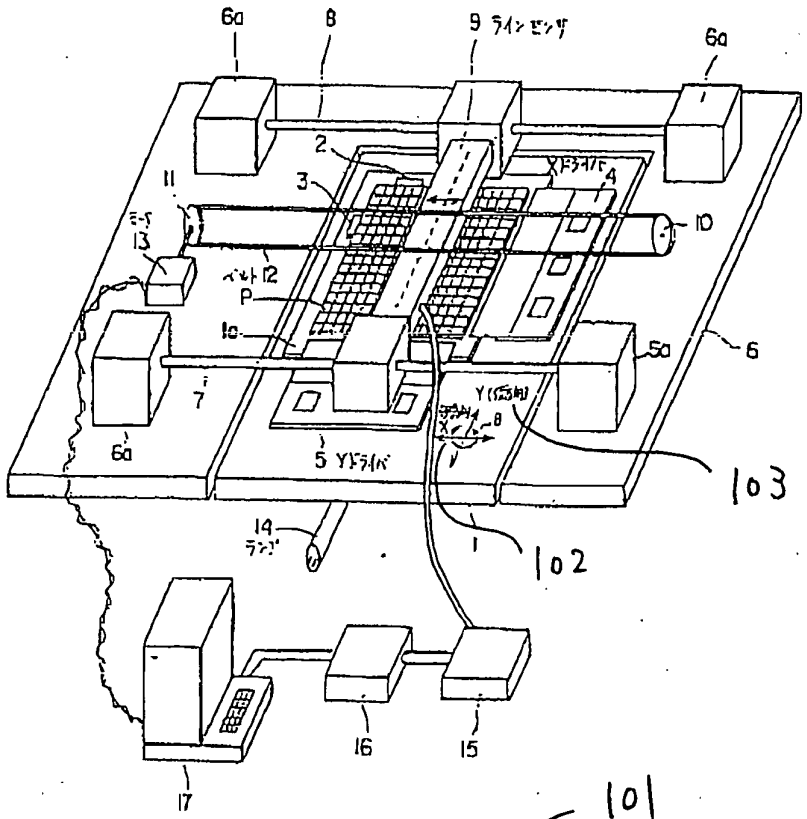
Fig. 4

401: CASE THAT ARRAY PITCH OF PHOTODETECTORS IS DIFFERENT FROM THAT OF PIXELS

Fig. 5

501: ILLUSTRATION OF PHOTODETECTOR OUTPUTS IN FIG. 4

502: LINE SENSOR OUTPUT




実施例の画素検査装置を示す概略斜視図

第 1 図

実用新案登録出願人 沖電気工業株式会社
代理人 弁理士 前 田 実

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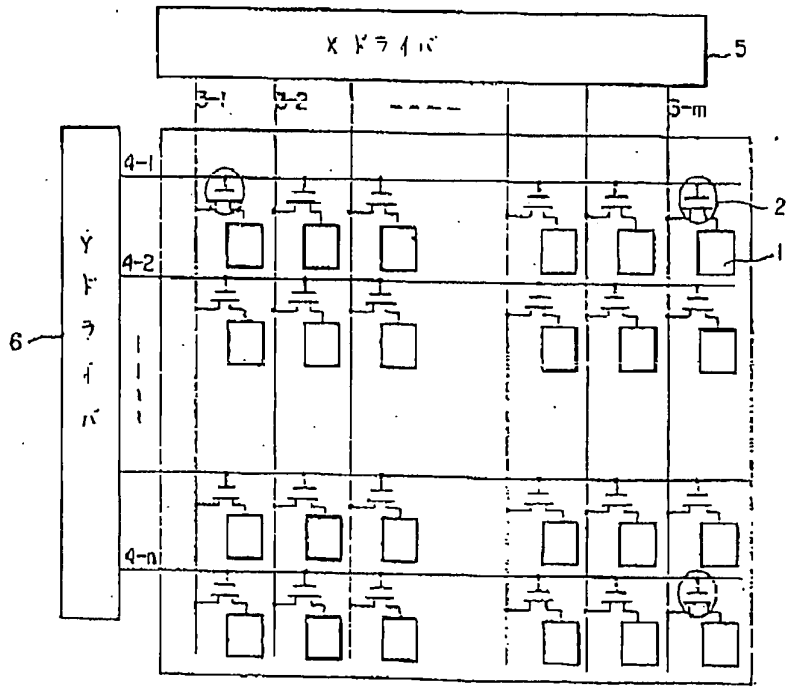
107




検査対象となる液晶表示パネルの回路図 ― 201

第２図

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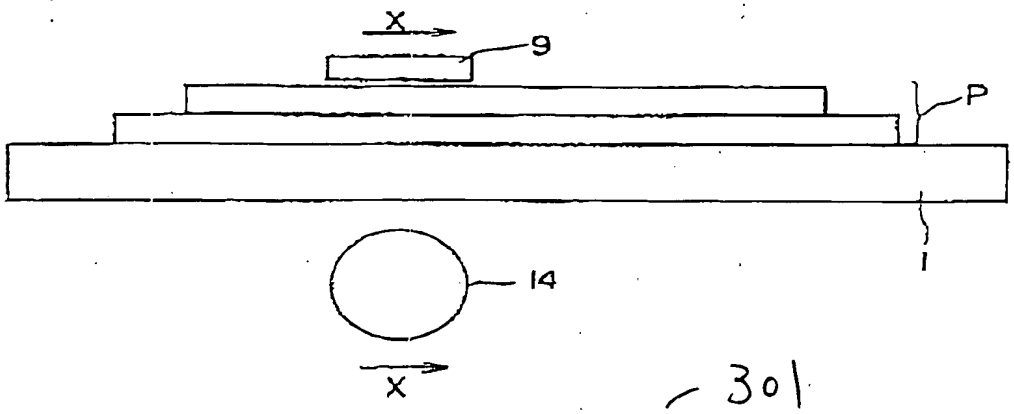
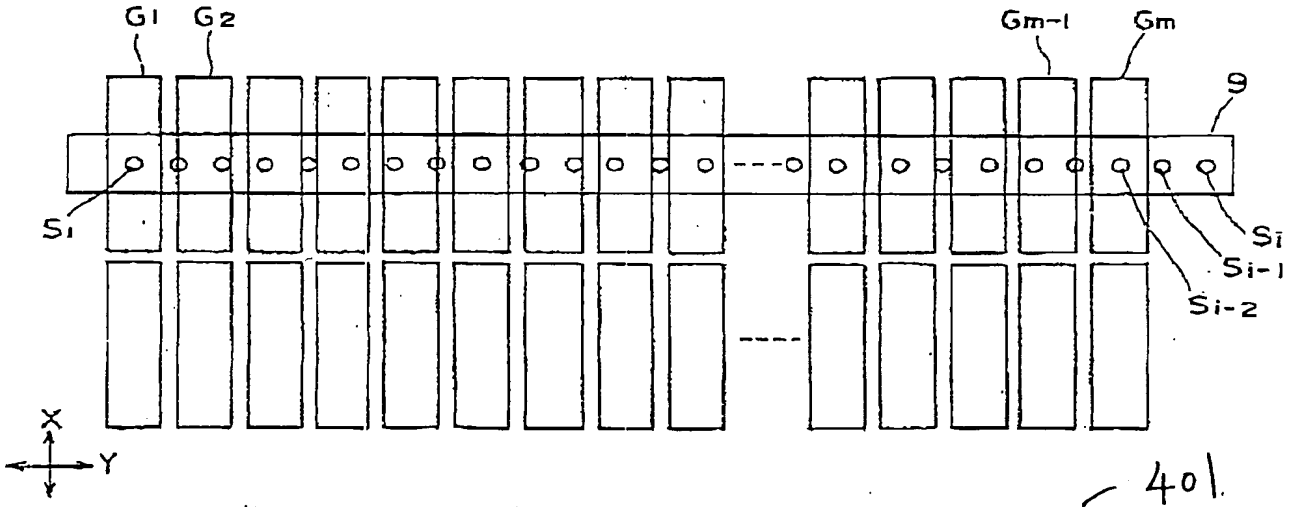
# 公開実用平成 4−55535




301

ステージ1付近を正面から見た図

## 第 3 図




401

画素の配列ピッチと受光素子の配列ピッチとが異なる場合

## 第 4 図

実用新案登録出願人 沖電気工業株式会社
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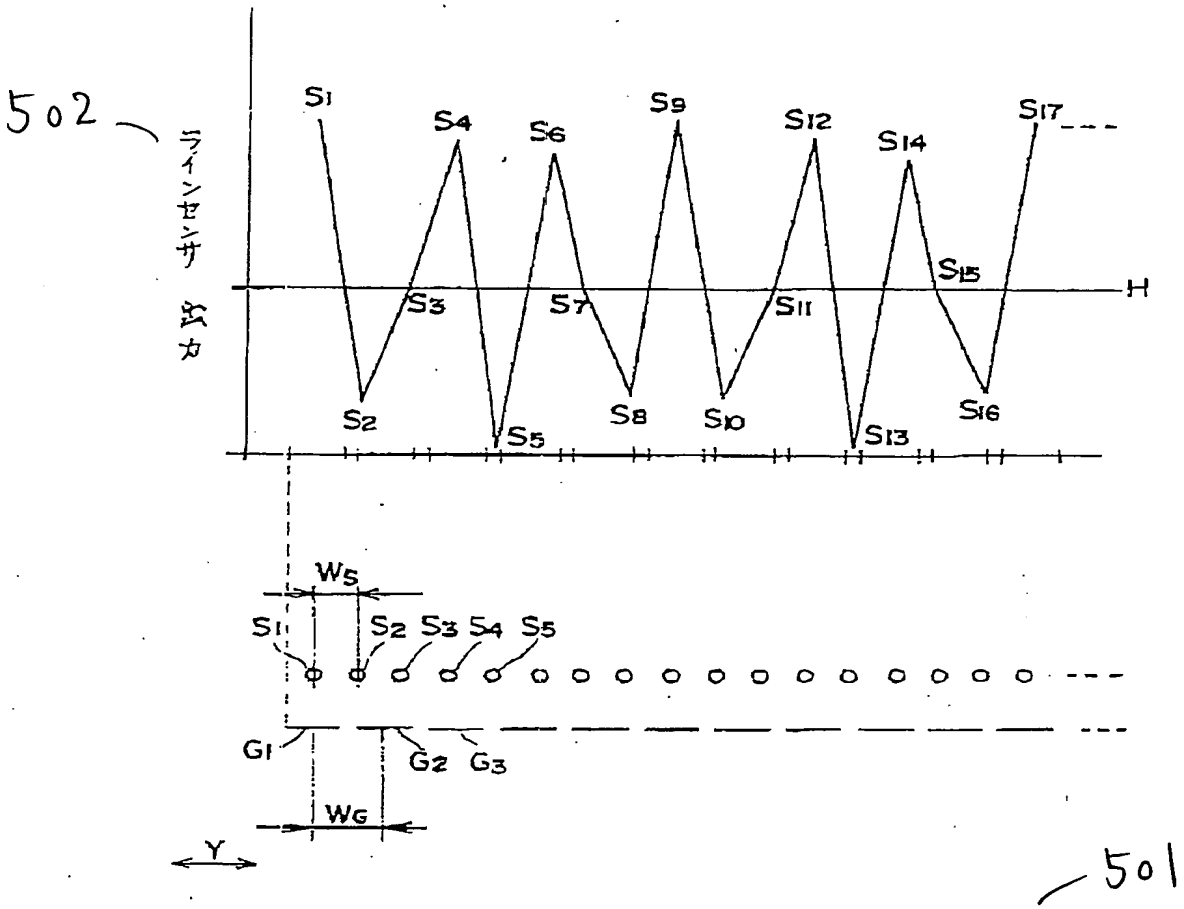


第4図の場合の受光素子出力を示す説明図

# 第 5 図

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